

Claims

[c1] What is claimed is:

1. A copper damascene process, comprising:
forming a dielectric layer overlying a substrate;
etching a damascene opening into said dielectric layer;
filling said damascene opening with copper or copper alloy;
treating a surface of said copper or copper alloy with hydrogen-containing plasma;
reacting said treated surface of said copper or copper alloy with trimethylsilane or tertramethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions; and
in-situ depositing, by PECVD, a silicon carbide layer capping on said copper or copper alloy.

[c2] 2. The copper damascene process according to claim 1 further comprising:
lining said damascene opening with a diffusion barrier layer;
forming a seed layer on said diffusion barrier layer; and
forming said copper or copper alloy on said seed layer.

[c3] 3. The copper damascene process according to claim 1

wherein said damascene opening comprises a contact or via hole in communication with a trench opening.

[c4] 4. The copper damascene process according to claim 1 wherein the step of reacting said treated surface of said copper or copper alloy with trimethylsilane or tertramethylsilane comprises following processing parameters: a trimethylsilane (or tertramethylsilane) gas flow in the range of 100 to 5000 sccm; a process temperature in the range of 300° to 450°; and a reaction duration in the range of 0.1 seconds to 30 seconds.

[c5] 5. A copper damascene process, comprising:
forming a dielectric layer overlying a substrate;
etching a damascene opening into said dielectric layer;
filling said damascene opening with copper or copper alloy;
treating a surface of said copper or copper alloy with hydrogen-containing plasma;
reacting said treated surface of said copper or copper alloy with trimethylsilane or tertramethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions; and
in-situ depositing, by PECVD, a silicon carbide layer capping on said copper or copper alloy, said layer silicon carbide being treated with in-situ ammonia plasma to remove contained oxygen of the deposited layer.

- [c6] 6. The copper damascene process according to claim 5 further comprising:
lining said damascene opening with a diffusion barrier layer;
forming a seed layer on said diffusion barrier layer; and
forming said copper or copper alloy on said seed layer.
- [c7] 7. The copper damascene process according to claim 5 wherein said damascene opening comprises a contact or via hole in communication with a trench opening.
- [c8] 8. The copper damascene process according to claim 5 wherein the step of reacting said treated surface of said copper or copper alloy with trimethylsilane or tertramethylsilane comprises following processing parameters: a trimethylsilane (or tertramethylsilane) gas flow in the range of 100 to 5000 sccm; a process temperature in the range of 300° to 450°; and a reaction duration in the range of 0.1 seconds to 30 seconds.